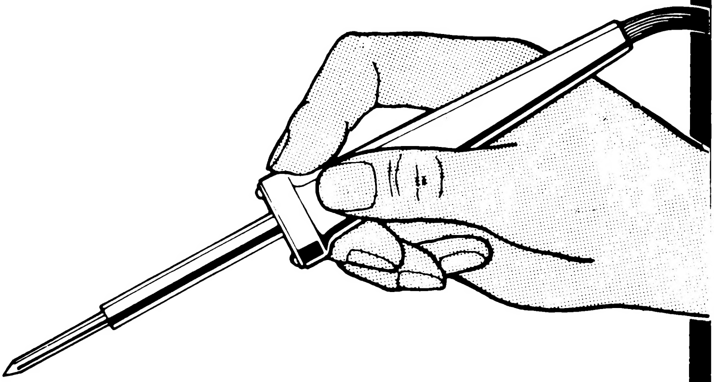
Guide to Kit Construction



This is a guide for newcomers to kit building. Follow the guidelines given here and your kit will be easier and more enjoyable to assemble and more likely to work first time.

This booklet covers the basics of tools, parts identification, construction methods and trouble shooting. Details for specific kits are given in each kit's construction manual.

DICK SMITH

P-227

TOOLS YOU WILL NEED

Only a minimum of tools is needed for most kits. These are:

- *A soldering iron, 10-30W rating
- *Three screwdrivers (one Philips)
- *A pair of side cutters (small)
- *A pair of long nose pliers
- *Wire strippers or a knife

Solder is included in the kits. If you buy additional solder make sure that it is 60/40 resin core. Using acid core solders will damage components and invalidate the guarantee. Some kits also involve some metalwork, so access to a drill will be needed. Other tools: spanners, alignment screwdrivers etc. are also needed from time to time. Suitable tools are available from all Dick Smith stores.

For testing, a multimeter with 20 000 ohms per volt sensitivity (such as the Dick Smith Q-1024) is essential.

FOLLOW THE MANUAL

Read each step completely — before starting. Make sure you understand everything that's involved.

TAKE YOUR TIME

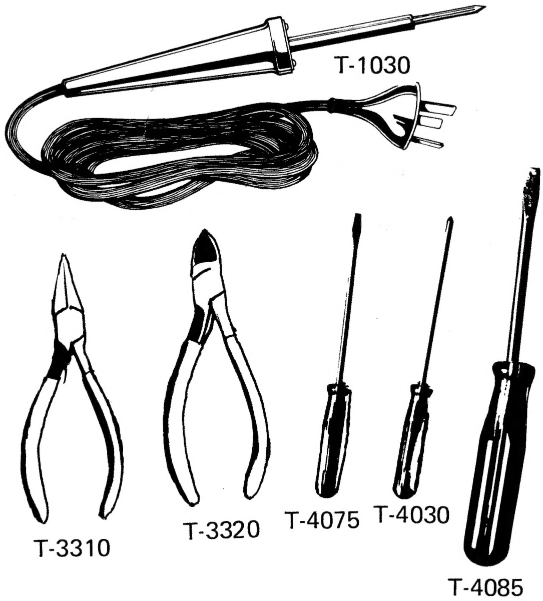
Allow yourself plenty of time to build the kit. Set aside an area where you can work undisturbed, and can leave the kit between sessions.

CHECK YOUR WORK

Refer frequently to the kit's instruction manual, check each step as it is completed.

CONTENTS

Tools 2
Soldering 2
Resistors 4
Potentiometers 4
Capacitors 5
Semiconductors 6
Transformers 7
Switches 8
Wire and cable 8
Construction Techniques 10
Using a multimeter 11
Mains Voltages 12
Troubleshooting 12
Missing parts 12
Guarantee 12



SOLDERING

Poor soldering is the major cause of kits not working. This is simply because most people do not take the time to learn how to solder properly and practise it.

THE IRON

The soldering iron used should be suited to electronic work. A wattage of from 10 to 30 watts is ideal, with a tip size from 1.5 to 4mm across. A chisel shape is usually best.

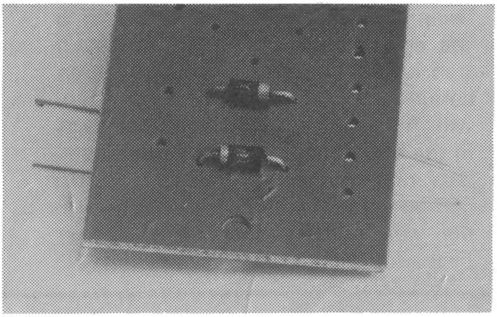
The tip should be kept clean at all times. The best way is to keep a damp sponge or cloth handy and wipe the iron on it occasionally. If the tip is pitted it will have to be reshaped by filing (except iron plated tips which must not be filed).

THE SOLDER

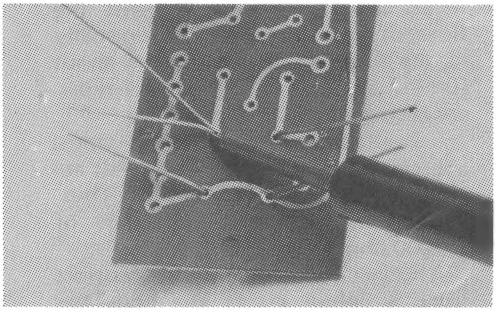
The best solder for general electronics use is 60/40 multicore (60% tin/ 40% lead with inbuilt resin flux). SAV-BIT is a variation of this type with 2% copper added to improve tip life. 'Acid core' solders must not be used.

METHOD

The joint must be clean and free from tarnish, lacquers etc. for the solder to adhere properly. If necessary, use sandpaper or a fine file to clean the joint.

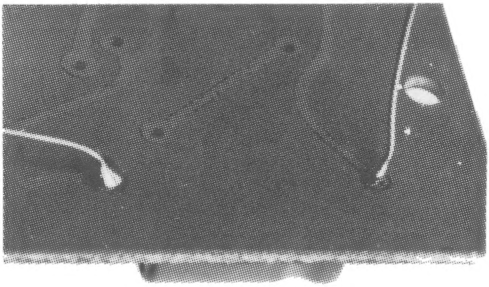


Make a good mechanical connection: bend leads of components mounted on printed circuit boards at 45° once inserted; and on wires connecting to switches, terminals etc. at 90°.



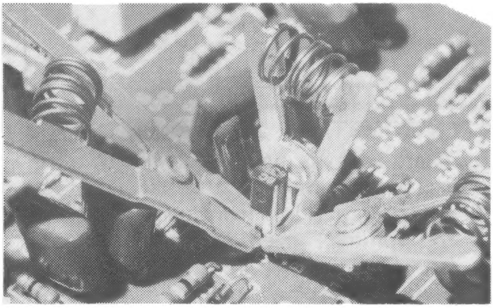
Hold the iron as you hold a pencil and apply it to the joint before the solder to pre-heat the joint (about one second for PC boards) then apply the solder to the joint and the iron. The solder will flow freely when the joint is hot enough. Remove the iron and and solder when the solder has flowed across the whole joint. If the solder forms a ball the joint needs more heat.

Don't move anything while the solder is cooling. If you do, re-heat and add a little more solder to ensure a clean joint.



The connection should be shiny and the solder should flow smoothly into it. If it looks cracked or frosty, the joint is dry and must be re-done.

If you've never used an iron before, do some practise runs first. Get the feel of the solder flow, and when to apply and remove the solder and the iron.



When soldering semiconductors and other sensitive components it is a good idea to hold the lead with pliers or a heatsink clip to prevent damage by overheating. This isn't necessary once you can solder fast and reliably.

When it is cool, inspect each joint carefully; look for solder 'bridges' shorting across PC tracks, pinholes and cracks in the joints.

COMPONENT IDENTIFICATION

One of the biggest problems for the beginning constructor is identifying the components correctly. The main trap is in the maze of numbers put on components by manufacturers. There will normally be a drawing of the parts in the kit manual, but identifying numbers may not be easy to find on the components themselves. As an example, what's described as a '741' IC may be marked LM741CN, N5741T, 741TC, MC1741CP1 or SN52741N. Confusing, isn't it? Notice though, that there is a '741' somewhere in all the numbers. The other numbers and letters indicate the manufacturer, and various batch and variety codes of the particular manufacturer. All these may be ignored as any of these ICs would work equally well in a circuit.

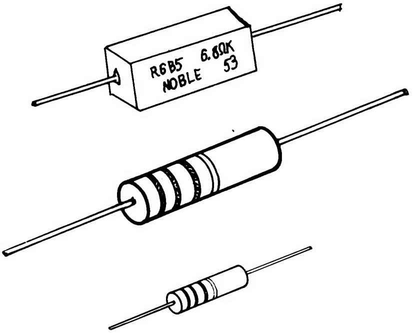
We will now go through the common components in our kits.

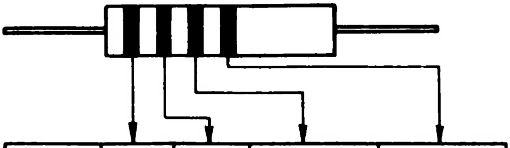
RESISTORS

So called because they 'resist' the flow of current. They are normally in the form of small cylinders about 10mm long. Some high wattage types are rectangular.

Resistance is measured in ohms, abbreviated to Ω or R. Thousands are indicated by 'k', millions by 'M'. Thus a 12k resistor has a resistance of 12 000 ohms.

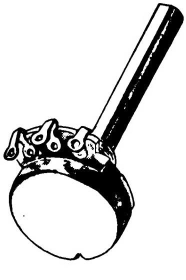
This value is marked on the resistors using a colour code. The body has (normally) four stripes. The first three indicate the resistance, the last the tolerance - how much the resistor may vary from its quoted resistance. The last band need not concern us as it is normally gold (5%) in our kits, which is accurate for most uses. To read the colour code, start with the band closest to the end. The first two are the significant figures, and the third is the number of zeroes following. The chart below shows the value of the different colours.

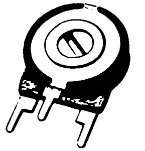




COLOUR	TENS	UNITS	MULTIPLIER	TOLERANCE
BLACK	0	0	1	20% (M)
BROWN	1	1	10	1% (F)
RED	2	2	100	2% (G)
ORANGE	3	3	1000	–
YELLOW	4	4	10000	–
GREEN	5	5	100000	–
BLUE	6	6	1000000	–
VIOLET	7	7	–	–
GREY	8	8	–	–
WHITE	9	9	–	–
GOLD	–	–	0.1	5% (J)
SILVER	–	–	0.01	10% (K)

POTENTIOMETERS are variable resistors. There are two main types in kits: normal potentiometers (often called pots) which are used as front panel controls for volume, speed or whatever; and 'trimpots' which are smaller devices mounted on the circuit board. These are used for initial adjustment of frequencies, levels etc. and are not normally adjusted once set.





CAPACITORS

Capacitors store a charge. They come in an enormous range of sizes and types with the most confusing identification of all the components

The most common types are mylar (greencaps), ceramic, electrolytic and tantalum. Some kits also use polystyrene and polyester. Electrolytic and tantalum capacitors are 'polarised', that is, have a positive and negative end which must be installed in the correct direction for the circuit to work.

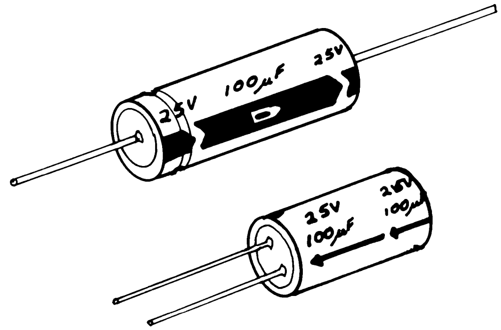
Capacitance is measured in Farads. This is too large a unit for most uses so various fractions are used: microFarad (uF)- a millionth of a Farad; nanoFarad (nF)- a thousandth of a microFarad; picoFarad (pF)- a thousandth of a nanoFarad. So 0.01uF= 10nF = 10 000pF.

Capacitors are marked in all these units - often without indicating which one! Electrolytics and some tantalum capacitors are marked in uF with the working voltage; ceramics in pF and mylar in pF or uF.

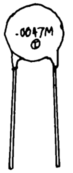
Many ceramic and mylar capacitors are marked using the IEC capacitor code, a system of three numbers and a letter giving the value and tolerance of a capacitor. The first two numbers are the significant figures, and the third the number of zeroes following (value in picoFarads). The letter indicates the tolerance - M = 20%; K = 10%; J = 5%. So a 123K is a 12 000pF or 12nF or 0.012uF 10% capacitor.

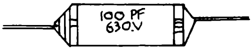
Some of the larger value greencaps are marked in uF (usually 0.1uF and larger). Smaller ceramics are usually marked in pF. This is why many constructors find capacitors confusing!

One more method is used to identify capacitors. Some polyester and tantalum capacitors are marked with a colour code similar to resistors.



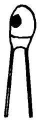
ELECTROLYTIC
Note arrow pointing to negative

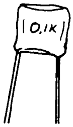


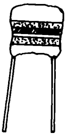


POLYSTYRENE

CERAMIC

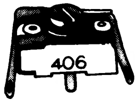


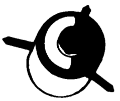


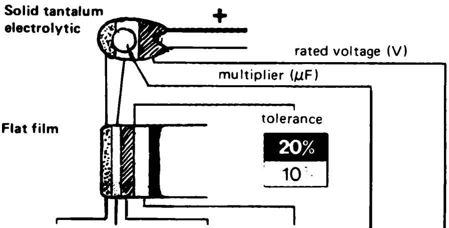


TANTALUM MYLAR POLYESTER

The positive (+) lead of a tantalum is identified in one of two ways. If colour coded, the right hand lead is positive when facing the dot (see below); or by a row of plus signs (+++) running down the side nearest the positive lead.







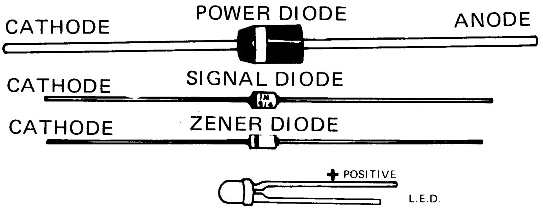
	figures	figures	multiplier (pF)	Vdc	multiplier (µF)	rated voltage (V)
BLACK	0	0	1		1	10
BROWN	1	1	1-	1--		1.6
RED	2	2	100	250		4
ORANGE	3	3	1k			40
YELLOW	4	4	10k	400		6.3
GREEN	5	5	100k			16
BLUE	6	6		630		
VIOLET	7	7			10^{-3}	
GREY	8	8	0.01		10^{-2}	25
WHITE	9	9	0.1		10^{-1}	2.5

CAPACITOR COLOUR CODE

DIODES

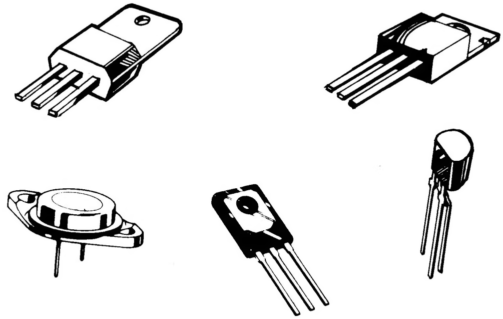
Diodes are used to convert AC current to DC (rectify), or to detect signals. Most are in the form of a black or clear cylinder 3 - 10mm long. Diodes are also polarised, with a cathode end (k), and an anode (a) end. The cathode is marked with a black or silver stripe, or in some small signal diodes, a white end. Always check that they are installed the right way round.

Light emitting diodes (LEDs) are a special type of diode which lights up red, green or yellow when voltage is applied. These are also polarised, and must be fed the correct voltage, with an appropriate resistor to limit the current.



TRANSISTORS

Transistors are the heart of most solid state equipment. They are used to amplify and switch signals. Transistors generally have three leads called emitter (e), base (b) and collector (c) and come in a wide variety of different cases. Always check that the leads are installed in the correct positions - two transistors may look the same, they may even work the same, but their leads could be differently oriented. The number of a transistor is normally printed on the case. Any other numbers or letters are manufacturers' codes and may be ignored. Typical transistors are illustrated alongside.



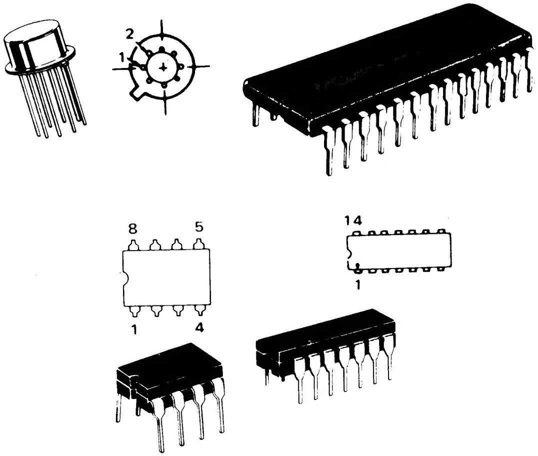
ALWAYS FOLLOW THE PIN CONNECTIONS ON THE CIRCUIT DIAGRAMS CAREFULLY

INTEGRATED CIRCUITS

Integrated circuits are just what their name indicates: a complete circuit in a single package. They perform a wide variety of functions - amplifying, timing, switching, counting - the list is enormous. They are usually packaged in a dual-in-line (DIL) package with from eight to forty pins.

ICs must be installed in the correct direction. One end will be marked with a notch or hole which must be installed as indicated in the circuit layout.

Identifying the right IC can sometimes be difficult due to the maze of numbers printed on them. See the first paragraph of the component identification section for clues to identifying the right IC.

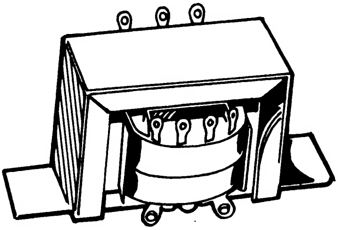


CMOS ICs

A special type of IC called CMOS requires careful handling. These are very sensitive to static electricity and come packed on special conductive foam for protection. Always install these ICs last, soldering the power and earth pins first. Make sure your soldering iron is properly earthed, and avoid touching the pins with your fingers. Follow the instructions in the kit carefully and if you have any doubts about soldering, buy sockets for the ICs.

TRANSFORMERS

Transformers are used mainly for reducing the 240V mains to a voltage suitable for powering the circuitry of a kit. All mains operated kits will include one. Connecting them is usually fairly simple as the 'primary' (mains side) and 'secondary' (low voltage side) are normally clearly marked. On transformers with 'flying lead' connections (wires coming directly out of the body), the red and black are normally the primary, and the two yellow and blue wires are the secondary. In this type the blue is a centre tap - a voltage halfway between the two yellow wires.

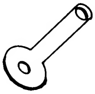


CONNECTORS

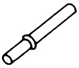
All kits include connectors of various types - mains, battery, audio - the list of uses and types is enormous. When there is a standard connection configuration, it will be included in the instructions.

OTHER PARTS

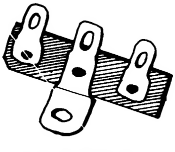
All kits include a number of parts used for mounting, controlling and interconnecting. Here are the most common: SOLDER LUGS are used for connecting a wire to a bolt - for earth connections etc. PC PINS - used for connecting wires to a printed circuit board. Handy because they can be soldered to after the board is mounted. TAGSTRIPS - used where a few components need to be mounted separately to the PC board. MAINS TERMINAL BLOCKS - these are the interconnection between the mains power cord and the circuitry of a kit. To use them strip about 8mm from the wires tin them, insert in the correct hole and tighten the screw - not too tightly or the wire could fracture. Make sure that no bare wire is outside the block.



SOLDER LUG

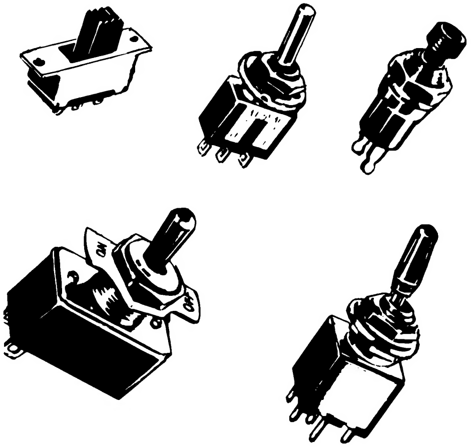


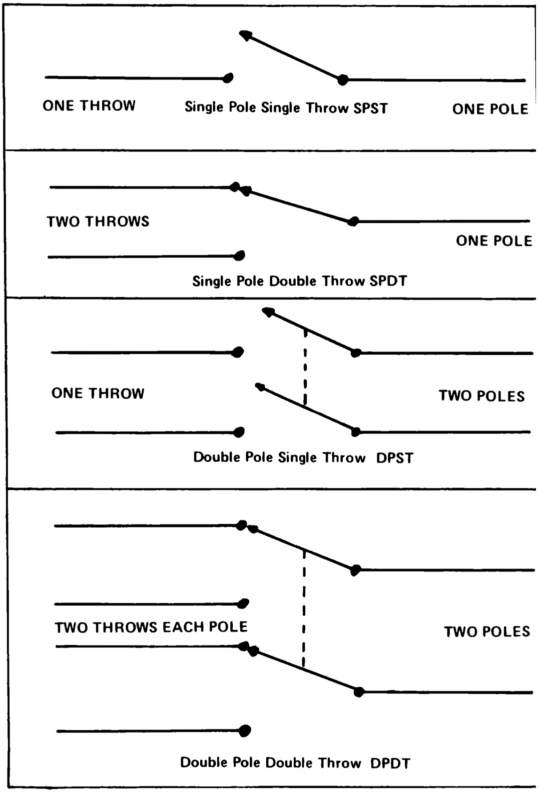
PC PIN



TAGSTRIP

SWITCHES are used for controlling various functions in kits. They come in various types - toggle, rotary, paddle, micro, and are identified by the number of 'poles' and 'throws' or 'ways'. This is usually given as four letters or numbers. SPST stands for Single Pole Single Throw - one pole which is either off or on; DPDT stands for Double Pole Double Throw - two separate poles which have two 'on' positions. The drawings at the right will clarify these descriptions.




ONE THROW
Single Pole Single Throw SPST
ONE POLE
TWO THROWS
ONE POLE
Single Pole Double Throw SPDT
ONE THROW
TWO POLES
Double Pole Single Throw DPST
TWO THROWS EACH POLE
TWO POLES
Double Pole Double Throw DPDT

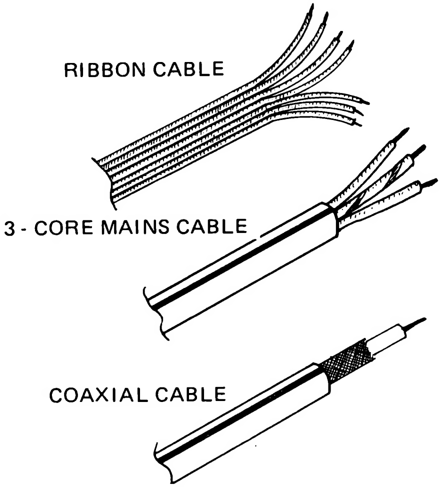
WIRE AND CABLE

You will come across three main types of cable in our kits: standard hookup wire - light, flexible wire in a wide range of colours for low voltage connections. This may be in the form of a flat 'ribbon' of twelve separate conductors joined together for easier handling. Mains hookup wire - heavier stiffer wire in black, red and green used for wiring power switches, mains plugs etc. There are currently two standards for mains colour codes. The old system uses red, black and green for active, neutral and earth wires respectively. The new international standard is brown, blue and yellow/green striped. At the moment both are used about equally, with the new standard eventually being the only one. Remember the equivalents: red and brown are for the active line, black and blue for the neutral and green and green/yellow are for the safety earth connection. Always make sure that any mains operated equipment, except double insulated equipment, is properly earthed. This protects you from dangerous shock situations.

The third type of wire you will come across is shielded or coaxial cable. This has one or more inner conductors surrounded by a twisted or braided shield.

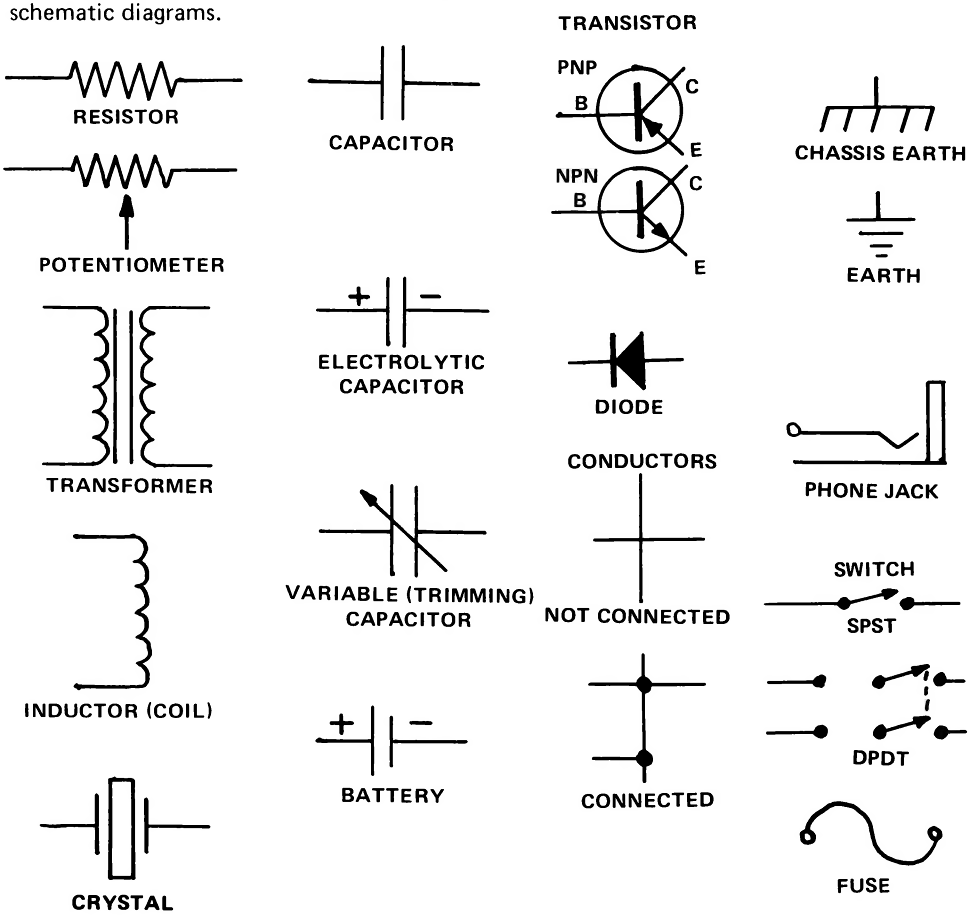
In use the outer shield is normally earthed, while the inner conductor(s) carry the signal. The earthed shield protects the conductors from outside interference. This is why this cable is used for low level audio and radio signals.

Coaxial cables used for radio and TV have an impedance - measured in ohms. Always use coax of the specified impedance; usually 75 ohm for TV and FM, and 50 ohm for CB and amateur radio use.



SCHEMATIC DIAGRAMS

These are the commonly used symbols for components on schematic diagrams.



CONSTRUCTION TECHNIQUES

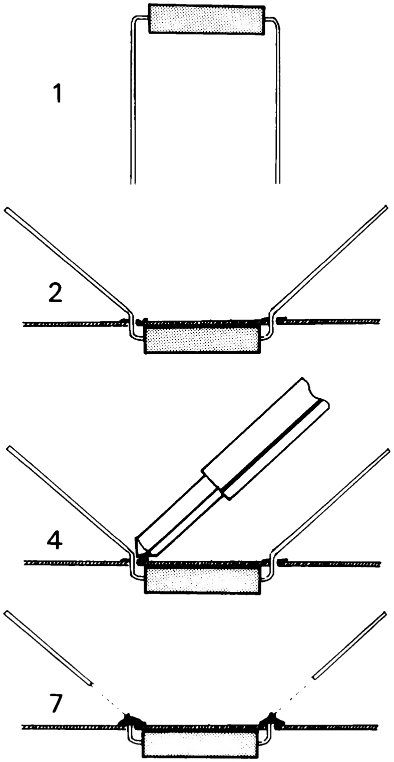
Most kits are assembled on a 'Printed Circuit Board' (PCB). This is a sheet of insulating material on which is etched the circuit layout in copper. Components are mounted on the non-copper side with their leads fed through the board and soldered to the copper tracks. When soldering, take care not to overheat as the tracks can lift off the board. Also avoid using too much solder, or you may 'bridge' across to another track causing a short circuit.

The drawings show how components are mounted on the PC board.

1. Bend component leads to fit the holes.
2. Insert leads in the correct holes and push down hard against the board. If the component is polarised, check that it is installed the right way round.
3. Turn the board over and bend the leads to 45°.
4. Hold the bit of your soldering iron against the component lead and the copper.
5. After pre-heating for about one second apply the solder to the joint and the iron.
6. When the solder has flowed across the pad remove the iron and solder. (For more detail, see the section on soldering on page 3.)
7. When cool cut the leads off flush with the solder.

The printed circuit boards are connected to the other components using hookup wire. Usually PC pins will be used to simplify connection. To connect to these first strip 5mm of insulation from the wire, tin the end (tinning is simply coating with solder) and the PC pin. Hold the wire against the pin and re-melt the solder. Hold still until the joint is solid.

When connecting wires to switches, potentiometers and terminals first strip and tin them as above; put a 90° bend in the stripped end and hook it through the terminal. Do not wrap it around the terminal or it will be difficult to remove if necessary.



COMPONENT DRESS

Dress is the name given to the neat layout of parts. Whilst it is not essential, neat consistent layout and construction makes any fault-finding much simpler, as well as producing a more professional and reliable finished product.

Bend leads to fit their PCB holes accurately, using long-nose pliers. This means easier installation and less strain on the point where the lead enters the component. All components except transistors should sit right on the board. Line up all resistors so that their colour codes can be easily read. Position capacitors so that their values can be read (except polarised types, which must go in the direction indicated).

USING A MULTIMETER

A multimeter is indispensable for testing and troubleshooting circuits. These notes will help you to use it effectively.

A typical multimeter measures volts (AC & DC), resistance and DC current.

To measure voltages, set the multimeter's range switch to the next voltage range higher than the voltage you want to measure. For example, to measure six volts, set the switch to ten volts. If you don't know what the voltage should be, set the switch to the highest voltage range (AC or DC) and measure the voltage. If it barely moves the needle, move the switch to the next range down. Do this until the needle falls around the middle of the scale.

Always make sure that you have set the meter to AC or DC as needed. Transformers and mains wiring are AC, transistor circuits are DC. When measuring DC, the red lead must be connected to the positive side, and the black to the negative. If the needle swings to the left, you have them the wrong way around.

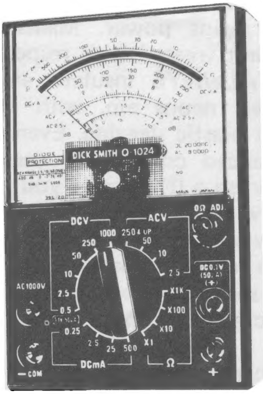
RESISTANCE MEASUREMENTS

When measuring resistance always make sure that no power is applied to the circuit or you will damage your meter or get a false reading.

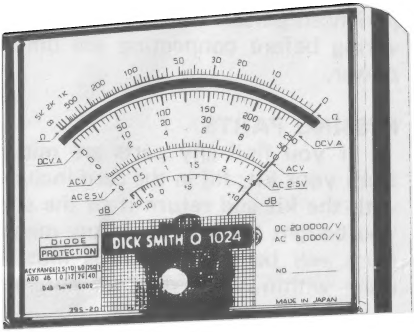
The most important thing to remember when measuring resistance is to make sure the meter is properly 'zeroed'. To zero the meter, set it on the appropriate range ('ohms X1') and hold the two probe tips together. Now adjust the knob labelled 'ohms adjust' until the meter needle is sitting over the zero mark on the right hand side of the meter scale. Notice that the ohms scale reads from right to left.

CURRENT MEASUREMENTS

To measure current, the point you wish to measure will have to be separated, as the meter will only measure current in series with the circuit. Adjust the range switch as for voltage measurements - start with the highest range and work down.



A TYPICAL MULTIMETER



A MULTIMETER CORRECTLY ZEROED FOR MEASURING RESISTANCE.

GENERAL RULES

-Check the position of the range switch before every measurement. Multimeters will not take much abuse (such as connecting to the mains on the ohms range!)

-Make sure that you're reading the right scale of the meter. These will be identified similarly to the range switch.

-Keep the meter flat when measuring, and read the scale from directly above- if your meter has a mirrored scale, line the needle up with its reflection. This will minimise reading errors.

-Re-zero the needle every time you measure resistance.

-Switch the meter off, or to the highest current range when not in use.

-Read your meter's instruction manual thoroughly.

MAINS VOLTAGES

Many of our kits are powered from 240V mains power. Mains voltages when not treated with respect can be fatal. ALWAYS insulate any mains switches, neons etc. with insulation tape or plastic sleeving. Even the most experienced constructor can accidentally brush a live wire — you might get away with it, but don't count on it. Follow mains wiring diagrams exactly - double checking everything. Always make sure the green wire is securely connected to the metal case of any project.

When treated carefully, taking all these precautions, mains power is quite safe. If you are uncertain, get an expeperienced person to check your mains wiring before connecting the unit to power.

MISSING PARTS

If you find any parts are missing from your kit, fill in the card included with the kit and return it to the store you bought the kit from. Any missing parts will be supplied. This must be done within seven days of purchase.

TROUBLESHOOTING

If a kit doesn't work when first switched on, switch it off immediately and disconnect the power.

Check the PC board for any solder bridges or dry joints. Re-solder any that look doubtful.

Are all components in the correct positions? Electrolytic capacitors, diodes, transistors and ICs the right way round?

Check all the wiring in this way. If no faults can be found after performing any tests described in the kit manual, try getting the help of an experienced person - possibly a local 'ham' or technician.

One more note on trouble shooting: DO NOT attempt any fault-finding with mains operated equipment unless you are absolutely certain that you know what you're doing — there is no room for mistakes with 240V wiring.

Most of our kits include a 'Sorry Dick, it doesn't work' coupon. This provides for repair of a faulty kit at a fixed charge. Remember though, if the kit is very badly wired it will be returned with your fee, so care in construction pays off.

Most faults in kits are due to poor soldering, or incorrectly installed parts. Faulty parts are extremely rare, as all parts are top quality and factory fresh.

DICK SMITH ELECTRONICS

NSW 125 York Street, SYDNEY. Phone 290 3377
147 Hume Highway, CHULLORA. Phone 642 8922
162 Pacific Highway, GORE HILL. Phone 439 5311
30 Grose Street, PARRAMATTA Phone 683 1133
263 Keira Street, WOLLONGONG Ph 28 3800
ACT 96-98 Gladstone Street, FYSHWICK. Phone 80 4944
VIC 399 Lonsdale Street, MELBOURNE. Phone 67 9834
656 Bridge Road, RICHMOND. Phone 428 1614
QLD 166 Logan Road, BURANDA. Phone 391 6233
SA 203 Wright Street, ADELAIDE. Phone 212 1962
WA 414 William Street, PERTH. Phone 328 6944

EXCEPT WHERE NOTED, ALL ITEMS SHOWN IN STOCK AT PRICES GIVEN AT TIME OF GOING TO PRESS
MAIL ORDER CENTRE: PO Box 321 North Ryde NSW 2113 POST & PACK EXTRA